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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Method for manufacturing at least one actuator, as well as a lead frame, optical reading and/or writing head and an optical reading and/or writing device

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G11B7/09

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Method for manufacturing at least one actuator, as well as a lead frame, optical reading and/or writing head and an optical reading and/or writing device

BACKGROUND OF THE INVENTION

The invention relates to a method for manufacturing at least one actuator, wherein each actuator comprises at least one substantial plastic actuator part.

Such a method is known from the US 5,999,501 patent, which is incorporated herein by reference. In the known method, a plurality of elastic members is integrally moulded with a lens holder and a stationary member, for producing an objective lens actuator. The lens holder and stationary member are composed of resin material. Said elastic members are wires which can be made, for example, of metals. An advantage of the known method is, that the actuator can be assembled in relatively little assembly steps.

A disadvantage of the known method is, that it is difficult to position said wires accurately during the moulding of said plastic actuator part. In US 5,999,501, positioning of the wires is achieved using a mould which makes contact with exposed parts of the wires, such that the wires are partly buried in the mould during the moulding of said plastic actuator part. However, such positioning method requires complicated movements of each of the wires and the mould with respect to each other before the plastic actuator part is moulded. Therefore, the known method is relatively slow, leading to a low productivity.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a method according to the preamble of claim 1, wherein the at least one actuator can be manufactured with sufficiently high precision and with a high productivity.

According to the present invention, this object is achieved by the features of claim 1.

According to the invention, a lead frame, comprising a number of leads, is provided, wherein said plastic actuator part of said actuator is injection moulded onto said lead frame. By using a lead frame, the leads can be moved and positioned with ease and at relatively high speed. Particularly, the lead frame provides for an in-line manufacturing process. Besides, the lead frame as such can position said leads accurately during the

moulding of said actuator part. Therefore, the present invention provides a relatively accurate and fast production method of said actuator.

The invention further relates to a lead frame, which, according to the present invention, is characterised by the features of claim 24. Such lead frame provides the abovementioned advantages during use.

Further, the invention provides an actuator which, according to the invention, is characterised by the features of claim 26. The actuator may be provided in a usual way with a lens holder with an objective lens and with a focussing coil and/or a tracking coil. Such actuator can be made relatively cheap, small, lean as well as precise. This actuator may be advantageously used in an optical reading and/or writing head for an optical reading and/or writing device, providing the aforementioned advantages thereto. Such a device may be further provided, as usual with a support for an optical disc.

Further advantageous embodiments of the invention are described in the dependent claims.

The invention will now be described in more detail on the basis of exemplary embodiments shown in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a perspective view of an embodiment of the invention;

fig. 2 is a perspective view of the leads of the embodiment shown in fig. 1;

fig. 3 is a perspective view of a lead frame according to the invention;

fig. 4 is similar view as fig. 3 of a lead frame band comprising a number of lead frames;

fig. 5 is a perspective view of a first manufacturing step according to the invention; and

fig. 6 is an perspective view of a second manufacturing step.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows an actuator 1, particularly for use in an optical reading and/or writing head of an optical reading and/or writing device. The actuator 1 comprises a first plastic part 2 and a second plastic part 3 which are movably connected to each other by elastic leads 5. Said second plastic actuator part is a lens holder 3 which is provided with a

transparent lens 9. Besides, the lens holder 3 is provided with electromagnets 8, 8', comprising a pair of parallel coils 8, located on opposite sides of the lens 9. These parallel coils 8 are arranged for moving the lens holder 3, and therefore the lens 9, in a first direction X by electromagnetic force, utilizing external magnetic means which are not shown in fig. 1. The lens holder 3 also comprises a third coil 8' which extends substantially perpendicular to said parallel coils 8. The third coil 8' provides for a movement in a second direction Z of the lens holder 3, perpendicular to said first direction X, with respect to the first plastic actuator part 2. The general operation of such actuator is known from practice, see for example US 5,999,501.

Said leads 5 provide spring means for coupling the first and second actuator part 2, 3 to each other. More particularly, the actuator 1 comprises two rows of substantially parallel leads 5 extending between said first and second actuator part 2, 3. In the present embodiment, each row of leads comprises two leads 5.

As is shown in fig. 2, the ends of said leads 5 are integrally provided with enlarged connection parts 5' for attaching the leads 5 firmly to said first and second actuator parts 2, 3. Said connection parts 5' are arranged for anchoring the plastic parts 2, 3 thereto. To this aim, the lead connection parts 5' comprise perforations 10 for mechanically attaching these connection parts 5' to the first and second plastic actuator parts 2, 3. Such mechanical attachment is relatively strong. The lead connecting parts 5' can have many alternative forms and shapes for providing said anchorage. Besides, a number of the lead connection parts 5', which are depicted on the left in figure 2, is provided with protruding parts 11, protruding from the first plastic actuator part 2. These protruding lead parts 11 may serve, for example, for connecting external wiring or such to the leads 5. Two of said protruding lead parts 11 are shown in fig. 1.

Furthermore, the lead frame 4 is provided with coil connection pins A, A', B, for connection of said coils 8, 8'. Two of said coil connection pins A are provided on the ends of an elongated coil interconnecting part 15. This coil interconnecting part 15 extends between the lower of the lead connection parts 5' which are depicted on the right in figure 2. These two coil connection pins A are not in direct electrical connection with the two nearby, lower lead connection parts 5'. The last-mentioned lower two lead connection parts 5' comprise coil connection pins A'. Besides, coil connection pins B are provided on the two lead connection parts 5' extending -in figure 2- above said lower lead connection parts 5'.

The present invention provides an advantageous method for manufacturing the actuator shown in fig. 1. According to the invention, a lead frame 4, comprising said leads 5,

is provided. One embodiment of such lead frame 4 is shown in fig. 3. According to the invention, said two plastic actuator parts 2, 3 are simply injection moulded onto the lead frame 4, particularly in such positions, that said two plastic actuator parts 2, 3 are coupled to each other via a number of said leads 5. This manufacturing method is explained below in more detail.

As is shown in fig. 3, the lead frame 4, used in the present manufacturing method, comprises a first subpart 4A and second subpart 4B. Each lead frame subpart 4A, 4B comprises two substantially parallel leads 5. The lead frame 4 further integrally comprises retaining parts 6, 7, comprising three parallel retaining strips 6 and a number of retaining leads 7. The retaining strips 6 are connected to the lead ends 5' by said retaining leads 7 for retaining said leads 5. Said first and second lead frame subpart 4A, 4B extend between said parallel retaining strips 7. The first and second lead frame subpart 4A, 4B and said lead retaining parts 6, 7 substantially extend along the same plane. Said interconnecting part 15 is retained by one or more retaining parts 16, 6, D. Said retaining parts 6, 7, 16, D can hold the leads 5 and the coil interconnecting part 15 in desired positions during the manufacturing of said actuator 1.

According to a preferred embodiment, at least part of said leads 5 are arranged for conducting at least one electric signal. To this aim, the lead frame 4 of the present embodiment is completely made of electrically conductive material, particularly at least one metal and/or alloy. Said signal may be, for instance, an actuator control signal or such.

As is shown in fig. 4, a number of lead frames 4, 14, 24, 34 can be provided in an integrally connected state, particularly as a lead frame band 104. From each of these lead frames 4, 14, 24, 34, a respective actuator 1 can be manufactured. Each lead frame can be manufactured relatively cheap and with high precision, for example by punching each lead frame 4 and/or lead frame band 104 or using any other suitable method. Preferably, the lead frame band 104 integrally comprises a number of strengthening members 17 which extend between the lead frames 4, 14, 24, 24 for providing a relatively rigid grid which holds the leads frames. In the present embodiment, said strengthening members are reinforcement strips 17, which extend perpendicular to said parallel retaining strips 6, 7 and attach these retaining strips 6, 7 to each other.

Figure 5 shows a first step of the present manufacturing method, wherein a lead frame 4 is provided with said actuator coils 8, 8'. In particular, the first and second coil 8 are connected to the coil connection pins A of the coil interconnection part 15 and the coil connection pins A' of the nearby lead connection parts 5'. Therefore, one terminal of the first

coil 8 is electrically connected to one terminal of the second coil 8 via the coil interconnecting part 15 and respective connection pins A. Each other terminal of the first and second coil 8 are connected to said lead connection parts 5' via respective coil connection pins A'. As is shown in fig. 5, said first and second coil 8 extend substantially perpendicular to the plane of the lead frame 4. The two terminals of the third coil 8' are connected to the coil connection pins B of the outer connection parts 5' of the leads of the second lead frame part 4B, such that the third coil extends substantially parallel to the lead frame 4. Said lead connection parts 5' and coil connection pins A, A', B connect said coils 8, 8' electrically to the leads 5. The spring arm leads 5 of the resulting actuator 1 can therefore serve to conduct electrical current to said coils 8, 8' during operation of the actuator.

The connection of the coils 8, 8' to the coil connection pins A, A', B can be achieved, for instance, using suitable welding techniques, arc welding, soldering and the like. The coil terminals are also be wound around the respective connection pins. In particular, said coils 8, 8' are wire wounded coils. Preferably, self-supporting coils 8, 8' are used so that no winding body has to be applied in the coils. From practice, several suitable types of wires are available for the production of such self-supporting coils, comprising for example adhesive, glue and/or thermoplastic coatings.

For forming the first and second plastic actuator part 2, 3, each of these parts 2, 3 is divided into a first plastic subpart 2A, 3A and a second plastic subpart 2B, 3B respectively. Fig. 6 shows a second step of the present embodiment of the invention, wherein said plastic actuator subparts 2A, 2B, 3A, 3B are injection moulded onto the lead frame 4, such that each plastic actuator subpart is coupled to two subsequent leads 5.

Particularly, said first plastic actuator subparts 2A, 3A are injection moulded on said first lead frame subpart 4A, wherein said second plastic actuator subparts 2B, 3B are injection moulded on said second lead frame subpart 4B. The first subpart 3A of the second plastic actuator part 3 is provided on the outer connection parts 5' of the first lead frame part 4A, such that said first and second coil 8 are partially encapsulated thereby. The second subpart 3B of the second plastic actuator part 3 is provided on the outer connection parts 5' of the second lead frame part 4B, such that said third coil 8' is at least partially encapsulated thereby. Besides, the second subpart 3B of the second actuator part 3 is provided with apertures 12 for receiving the parts of the first and second coil 8 that extend from the first subpart 3A of the second actuator part 3, as is explained below. Besides, both subparts 3A, 3B of the second lead frame part 3 are provided with lens apertures 13, 13' for receiving said lens 9.

Fig. 6 further shows, that the first subpart 2A of the first plastic actuator part 2 is provided on the inner connection parts 5' of the first lead frame part 4A, whereas the second subpart 2B of that first actuator part 2 is provided on the inner connection parts 5' of the second lead frame part 4B.

Since the leads 5 are retained by the retaining parts 6, 7 of the lead frame 4 during the injection moulding step of the plastic actuator parts 2, 3, the actuator dimensional accuracy is relatively high. This enables the production of relatively small actuators 1. Preferably, said first actuator subparts 2A, 3A and second plastic actuator subparts 2B, 3B are moulded simultaneously, so that the actuator can be manufactured relatively fast and precise, particularly using the same mould. Besides, relatively little of assembly-parts are involved in producing the actuator 1, whereas the logistics of the actuator assembly are relatively simple.

The lens 9 can be provided in said lens holder 3 in different ways. For example, the lens 9 can be a plastic integrated lens which is moulded in one shot with said first and/or second subpart 3A, 3B of the second plastic actuator part 3. In that case, an optically suitable injection moulding polymer can be used for moulding the lens. Alternatively, the lens 9 and lens holder subparts 3A, 3B are manufactured separately, after which the lens 9 is mounted in the lens holder 3.

In fig. 6, the first and second lead frame subpart 4A, 4B are in a first position with respect to each other, particularly extending substantially next to each other, along the same plane. In this first position, the lead frame subparts 4A, 4B receive said first and second plastic actuator subpart 2A, 3A, 2B, 3B during the injection moulding thereof. After that, said lead frame subparts 4A, 4B are brought or folded to a second position with respect to each other for bringing said plastic actuator subparts 2A, 3A, 2B, 3B together. In this second position, the first and second lead frame subpart 4A, 4B are located substantially opposite each other. Then, the plastic subparts of each plastic actuator part 2, 3 are attached to each other, such that the two plastic actuator parts 2, 3 are formed. The plastic subparts can be attached to each other in different ways, for example by adhesive material, clicking, welding, laser welding or such. In said second position, the parts of said first and second coil 8 that reach out the first subpart 3A of the second actuator part 3 are received by the coil apertures 12 of the opposite second plastic subpart 3B.

After the folding of the lead frame 4 to said second position and the formation of the two plastic actuator parts 2, 3, said retaining parts 6, 7, 16, C can be removed from said lead frame subparts 4A, 4B. Removal can be achieved in different ways, for example

punching, cutting, laser cutting or any other suitable way. The resulting product is the actuator 1 as shown in fig. 1. Alternatively, said retaining parts 6, 7, 16, C may be removed after the moulding of said plastic actuator subparts, before the lead frame 4 is brought to said second position.

In figures 5 and 6, the manufacturing steps are shown using only a single lead frame. However, a number of integrally connected lead frames 4, 14, 24, 34, as shown in fig. 4, can also be used. Then, the different lead frames 4, 14 24, 34 can be separated from each other, for example, before or after the moulding of said plastic actuator subparts 2A, 2B, 3A, 3B, so that each lead frame can be brought into said second position for finishing the respective actuator 1.

Although the illustrative embodiments of the present invention have been described in greater detail with reference to the accompanying drawing, it is to be understood that the invention is not limited to those embodiments. Various changes or modifications may be effected by one skilled in the art without departing from the scope or the spirit of the invention as defined in the claims.

The optical element may comprise, for instance, one or more lenses, optical fibres, mirrors and/or other types of optical elements.

Besides, said actuator may be arranged and suitable for use in an optical reading and/or writing head of an optical reading and/or writing device. Besides, the actuator may serve for actuation of other elements than optical elements.

During the steps of providing the coils, plastic parts and/or any other parts onto the lead frame, the lead frame 4 may be an integral part of a lead frame band 104 or such. On the other hand, a lead frame 4 can be separated from a subsequent lead frame before it is used to receive actuator parts. Further, each plastic actuator part 2, 3 may be injection moulded onto more than one lead frame 4 at the same time.

Besides, the lead frame 4 may be made from any material which is suitable to the desired operation of said leads. The lead frame 4 may comprise for example non-polymer material. The lead frame 4 comprises a number of leads 5, for example at least one, preferably at least two, more preferably at least four, for coupling said plastic actuator parts 2, 3.

Furthermore, the actuator 1 may comprise one or more electromagnets 8, 8', which may be orientated in different, suitable positions for moving part of the actuator 1.

The injection moulding of said plastic parts can be achieved using different materials, for example polymer plastics or such.

Further, parts of the lead frame 4 and each plastic actuator part 2, 3 can be attached to each other in different ways, for example mechanically, for instance via perforations 10 in the lead frame 4, or by a suitable adhesive or other suitable means.

CLAIMS:

1. Method for manufacturing at least one actuator, wherein said actuator (1) comprises at least one substantial plastic actuator part (2, 3), wherein a lead frame (4), comprising a number of leads (5), is provided, wherein said plastic actuator part (2, 3) of said actuator (1) being injection moulded onto said lead frame (4).

2. Method according to claim 1, wherein said actuator (1) comprises at least two separate plastic parts (2, 3) which are injection moulded in such positions on said lead frame (4), that said at least two plastic actuator parts (2, 3) are coupled to each other via a number of said leads (5).

3. Method according to claim 1 or 2, wherein said actuator (1) is provided with spring means (5) for coupling different actuator parts (2, 3), wherein the spring means are provided by at least part of said leads (5) of the lead frame (4).

4. Method according to any of the preceding claims, wherein at least part of said leads (5) is arranged for conducting at least one electric signal, wherein said leads (5) particularly comprise electrically conductive material, more particularly at least one suitable metal and/or alloy.

5. Method according to any of the preceding claims, wherein said lead frame (4) comprises at least one retaining part (6, 7) for retaining said leads (5), wherein said retaining part (6, 7) is at least partially removed from said leads (5) after the moulding of said plastic actuator part (2, 3).

6. Method according to any of the preceding claims, wherein said at least one plastic actuator part (2, 3) comprises a first plastic subpart (2A, 3A) and a second plastic subpart (2B, 3B), wherein said lead frame (4) comprises a first and second subpart (4A, 4B), wherein said first plastic actuator subpart (2A, 3A) is injection moulded on said first lead

frame subpart (4A), wherein said second plastic actuator subpart (2B, 3B) is injection moulded on said second lead frame subpart (4B).

7. Method according to claim 6, wherein said first actuator subpart (2A, 3A) and second plastic actuator subpart (2B, 3B) are moulded simultaneously.

8. Method according to claim 6 or 7, wherein said first and second lead frame subpart (4A, 4B) are in a first position with respect to each other during the moulding of said first and second plastic actuator subpart (2A, 3A, 2B, 3B), for moulding these plastic subparts separately from each other, wherein said lead frame subparts (4A, 4B) are brought to a second position with respect to each other after the moulding of said actuator subparts (2A, 3A, 2B, 3B) for bringing said plastic actuator subparts together.

9. Method according to claim 8, wherein said first and second lead frame subpart (4A, 4B) extend substantially along the same plane in said first position.

10. Method according to claim 8 or 9, wherein said first and second lead frame subpart (4A, 4B) are located substantially opposite each other in said second position.

11. Method according to any of the preceding claims, wherein at least two lead frames (4, 14) are provided for manufacturing at least two respective actuators.

12. Method according to claim 11, wherein said at least two lead frames (4, 14, 24, 34) are integrally connected, for example in a lead frame band (104).

13. Method according to claim 12, wherein said at least two lead frames (4, 14, 24, 34) are separated from each other before or after the moulding of said plastic actuator part (2, 3).

14. Method according to any of the preceding claims, wherein said lead frame (4) comprises at least one row of leads (5), wherein each at least one plastic actuator part (2, 3) is coupled to at least two subsequent leads (5).

15. Method according to any of the preceding claims, wherein said at least one actuator (1) is provided with at least one electromagnet (8), particularly a coil, preferably before the moulding of said plastic actuator part (2, 3).

16. Method according to claim 15, wherein said electromagnet (8) is connected to at least part (5; 15) of said lead frame (4).

17. Method according to claims 4 and 16, wherein said electromagnet (8) is electrically connected to at least part of said leads (5).

18. Method according to any of claims 14-16, wherein said at least one actuator (1) is provided with at least two first electromagnets (8), wherein said lead frame (4) is provided with an interconnecting part (15) for connecting said first electromagnets (8) electrically to each other.

19. Method according to any of the preceding claims, wherein said actuator (1) is provided with at least one optical element (9), wherein the actuator (1) is arranged for moving said optical element.

20. Method according to claim 19, wherein said optical element (9) is a lens, a mirror, and/or an optical fibre.

21. Method according to claim 19 or 20, wherein said optical element (9) is formed by injection moulding during the injection moulding of said plastic actuator part (2, 3).

22. Method according to any of the preceding claims, wherein said actuator (1) is arranged and suitable for use in an optical reading and/or writing head of an optical reading and/or writing device.

23. Method according to any of the preceding claims, wherein said lead frame (4) is arranged for anchoring said plastic actuator part (2, 3) thereto, wherein the lead frame (4) particularly comprises a number of perforations (10) to provide said anchorage.

24. Lead frame, arranged for use in a method according to any of the preceding claims.

25. Lead frame band, comprising at least one lead frame according to claim 24.

26. Actuator, characterised in that the actuator (1) is manufactured by a method according to any of the claims 1-23.

27. Optical reading and/or writing head comprising an actuator (1) according to claim 26.

28. Optical reading and/or writing device comprising the reading and/or writing head according to claim 27 and further comprising a support for an optical disc.

29. Method for manufacturing a lead frame according to claim 24 and/or a lead frame band according to claim 25, for example by punching the lead frame (4) and/or lead frame band.

ABSTRACT:

Method for manufacturing at least one actuator, wherein said actuator (1) comprises at least one substantial plastic actuator part (2, 3), wherein a lead frame (4), comprising a number of leads (5), is provided, wherein said plastic actuator part (2, 3) of said actuator (1) is injection moulded onto said lead frame (4). The invention further provides a lead frame, arranged for use in such method, a lead frame band, comprising at least one such lead frame, as well as an optical reading and/or writing head and an optical reading and/or writing device.

(Fig. 1)

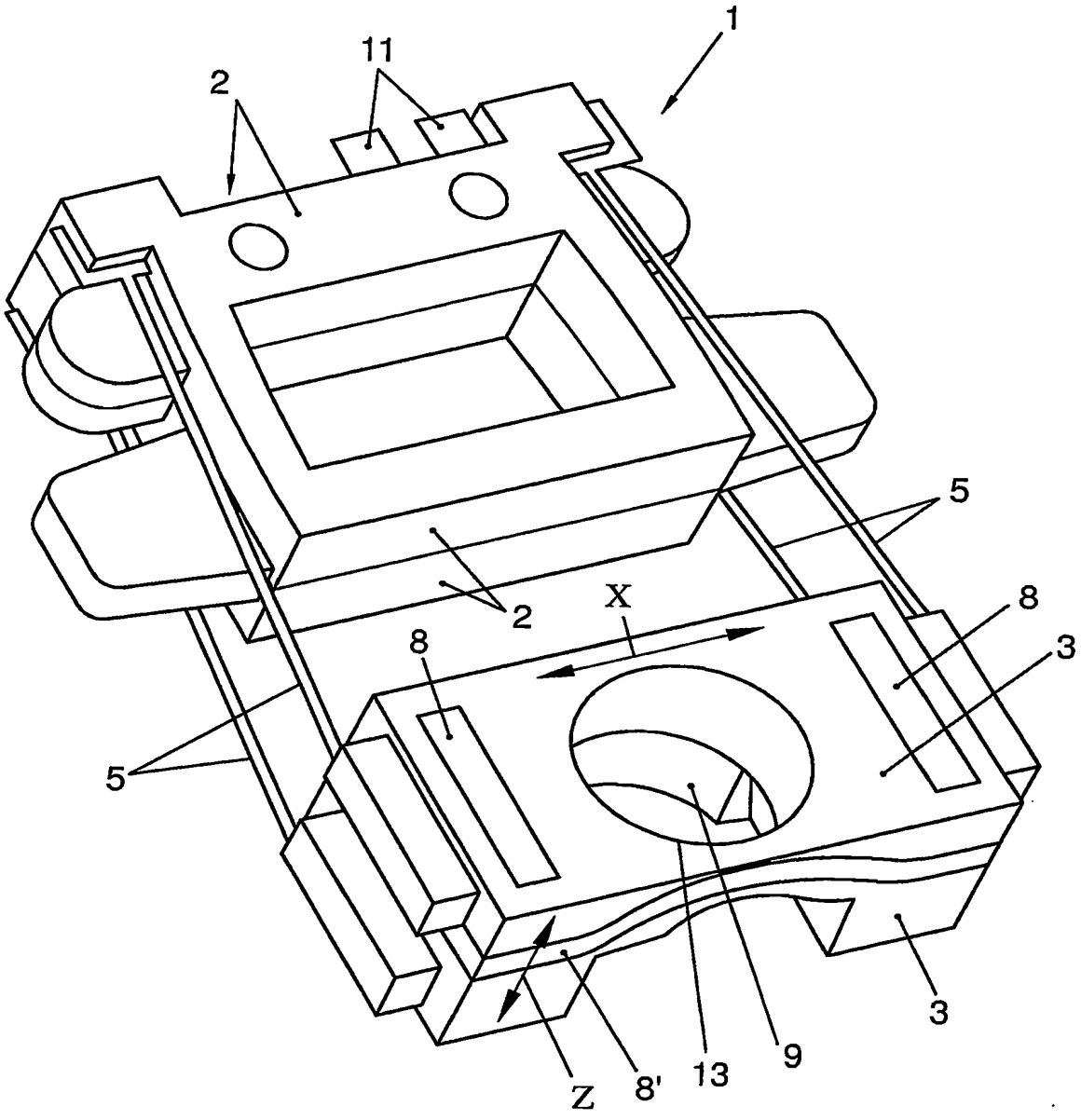
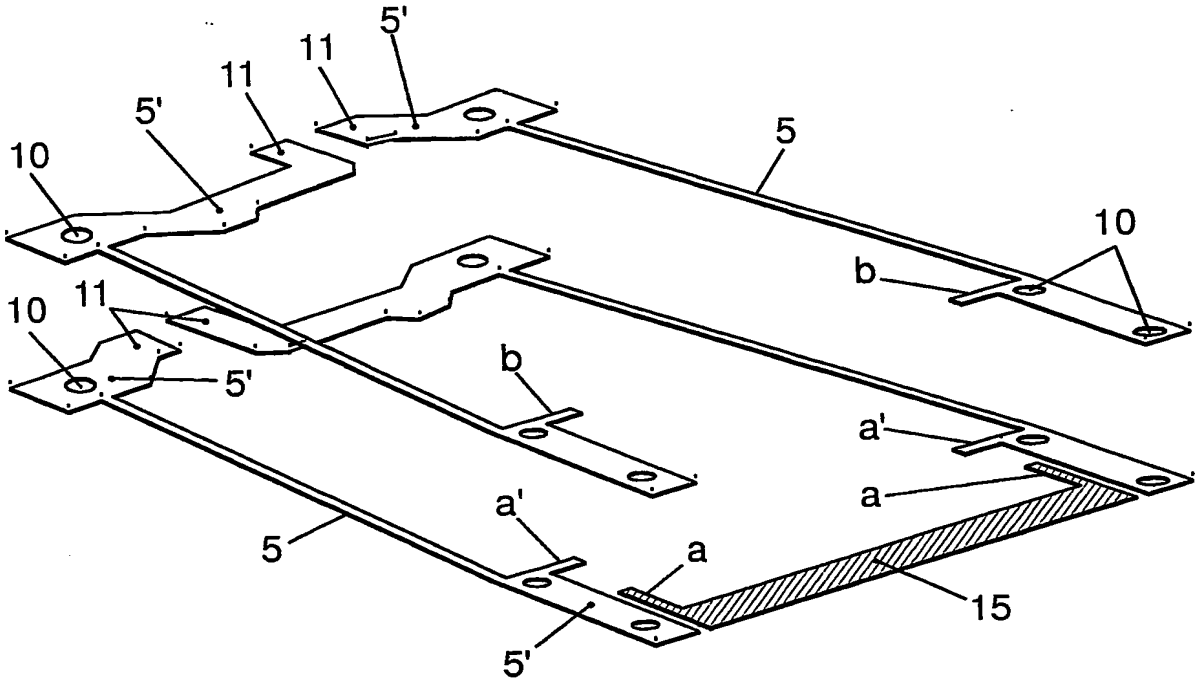


FIG.1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a
a'
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15
5'

FIG.2

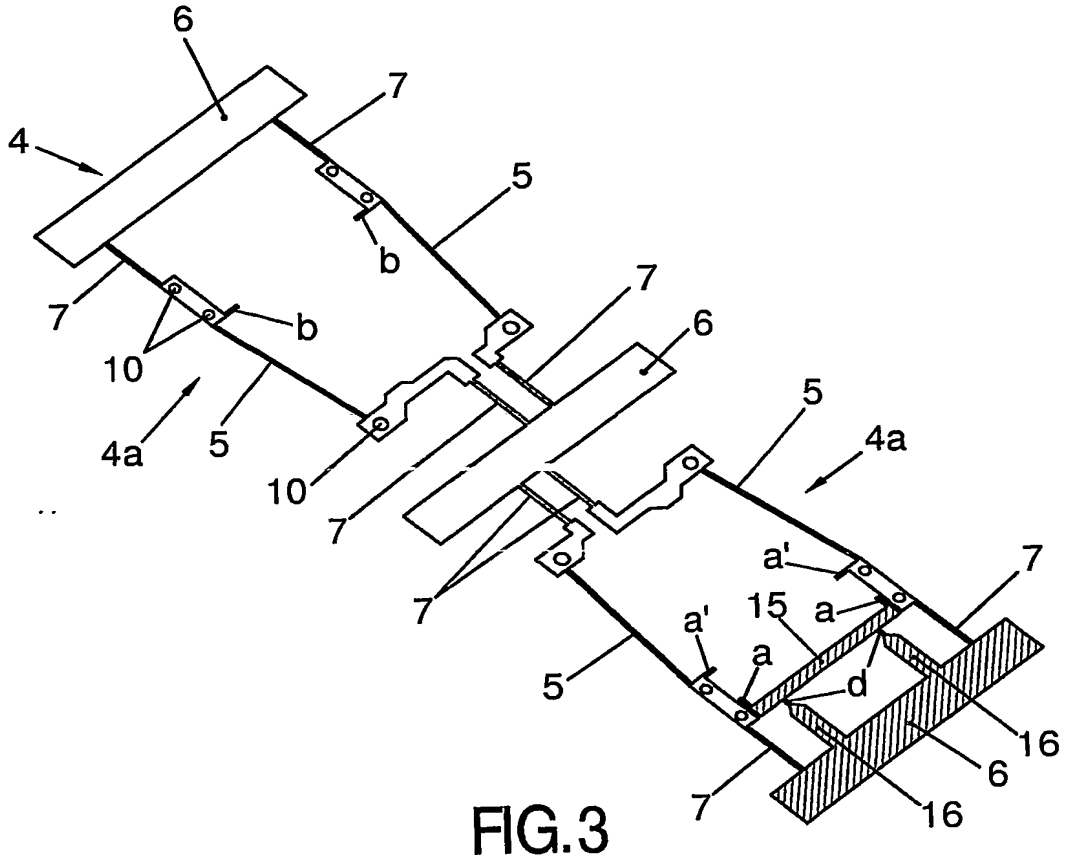
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FIG.3

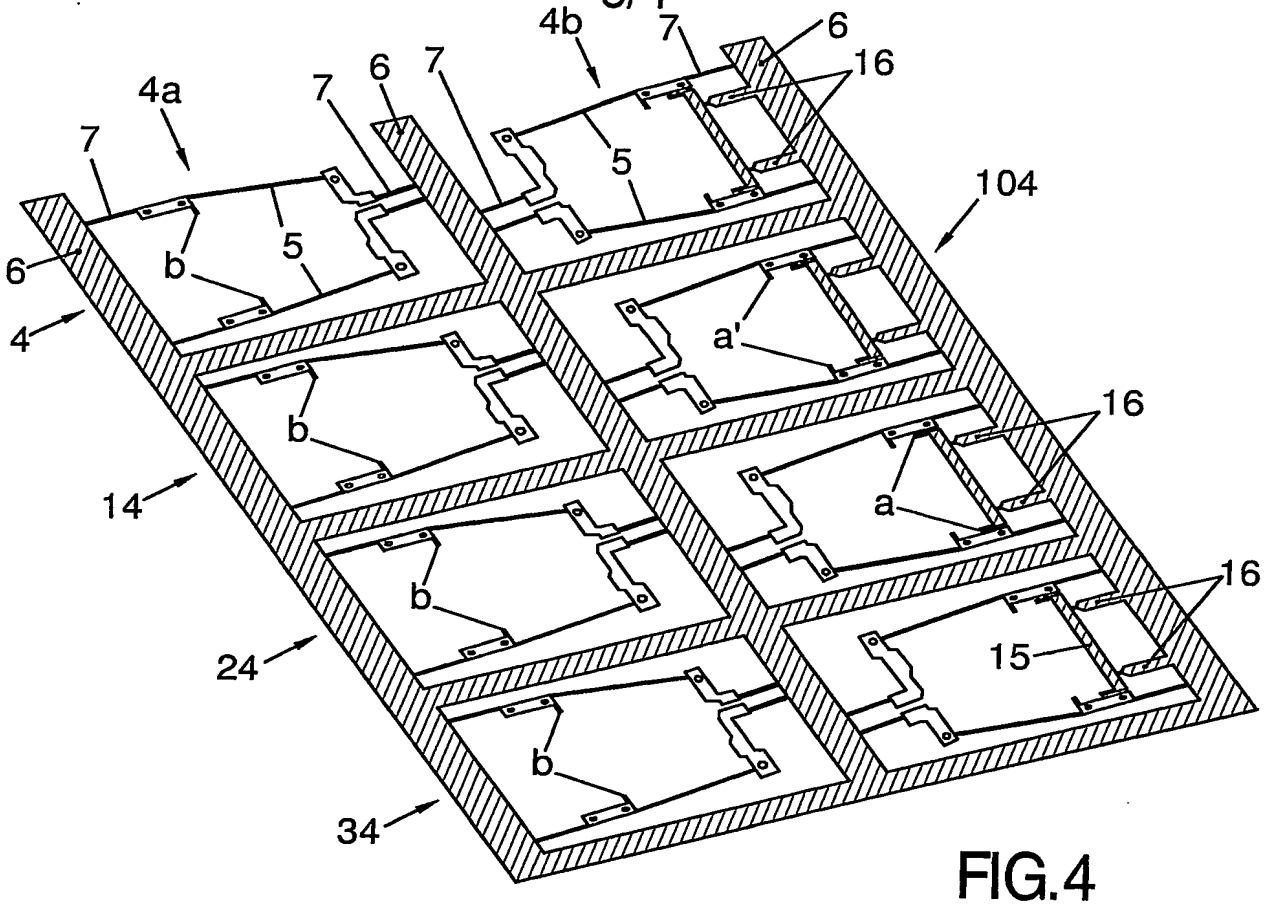
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FIG.4

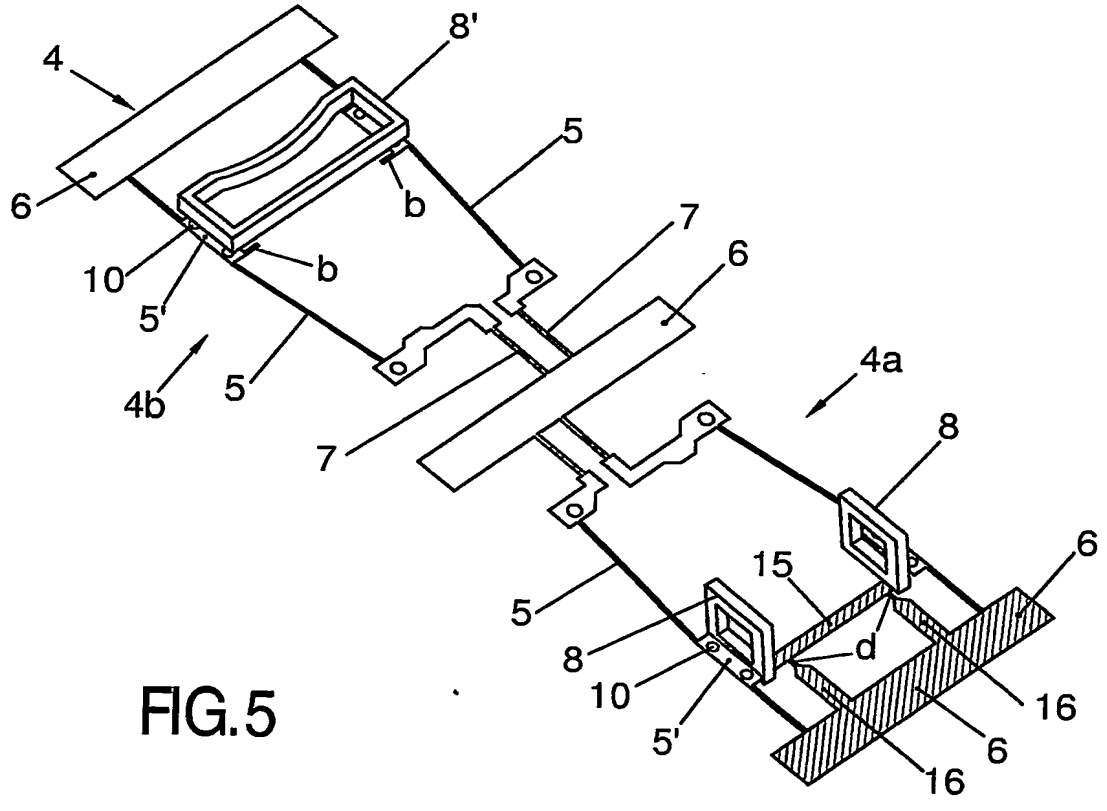
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FIG.5

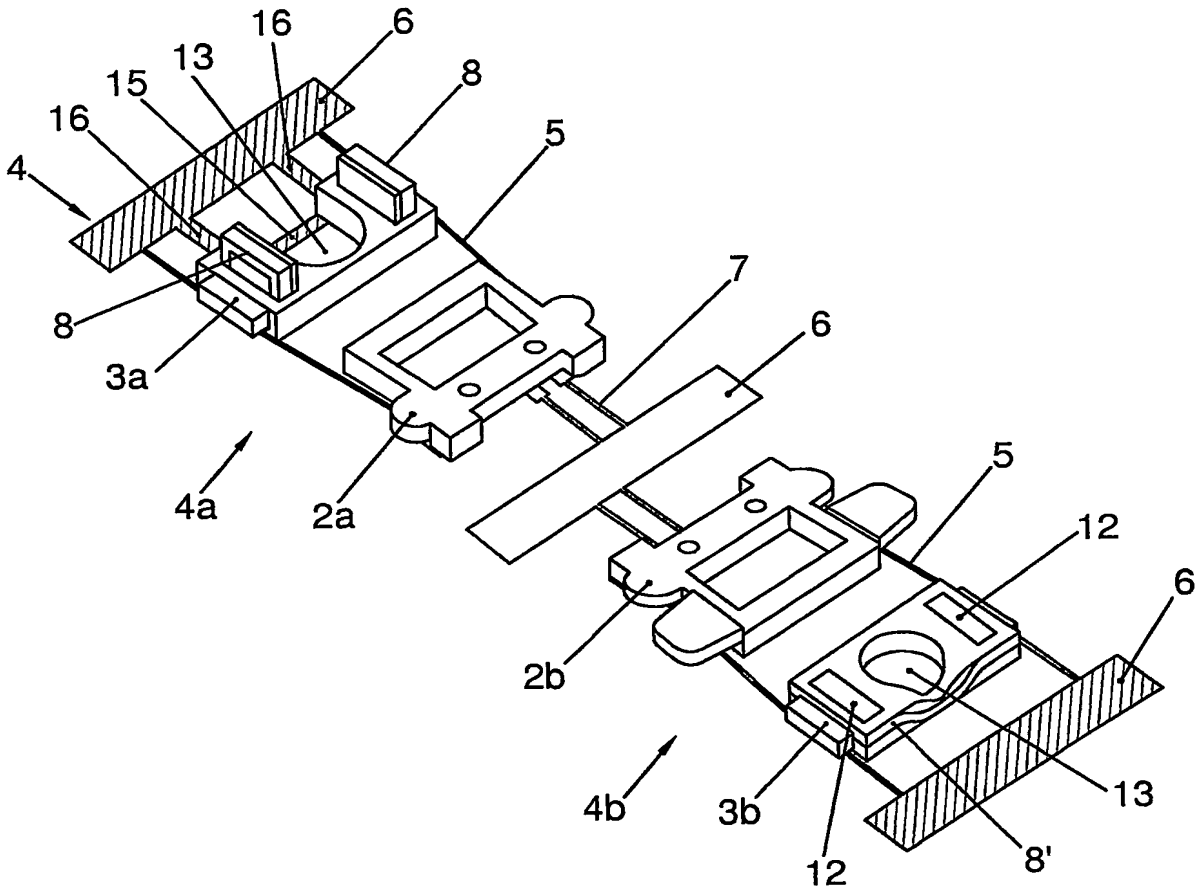

FIG.6